Conservation of mayflies (Ephemeroptera) especially *Coloburiscoides* in the Victorian Alps: impediments and threats

PJ Suter and P McGuffie

Department of Environmental Management and Ecology, La Trobe University
PO Box 821, Wodonga, Victoria 3689

Abstract
The aquatic insects are still poorly represented in terms of conservaiton and protection in Victoria. The main impediments for this were identified over a decade ago and all remain valid today. Recent national collections of aquatic invertebrates have been used to determine distribution and habitat requirements for more than 200 macro-inveterbrates, and this has enabled the identification of a number of species that have restricted distributions and may be candidates for conservation listing. An example, using the mayfly genus *Coloburiscoides*, highlights how the perception that these animals are widespread and common may mask the reality of individual species being rare and restricted in their distribution, and that the effects of climate change may hasten their decline. (*The Victorian Naturalist* **124** (4) 2007, 273-277)

Introduction

The aquatic insects, although highly diverse in Victoria, are very poorly represented in terms of conservation and protection. Under the *Flora and Fauna Guarantee Act* there are only 13 species of aquatic insect classified as Critically Endangered, Endangered, Threatened, Vulnerable or Data Deficient. Only caddisflies (Trichoptera) and stoneflies (Plecoptera) have a conservation status under the Act. This implies that aquatic insects are not of major concern for conservation, but there are a number of important reasons for the absence of many of the other insect orders. Butcher and Doeg (1995) identified a number of reasons for this including poor taxonomic knowledge, the incomplete knowledge of insect life cycles, poor systematic collections that give good knowledge of distributions, and the lack of coordination between organisations that collect from the aquatic habitats.

All these impediments still exist today even though there has been considerable effort to rectify these shortcomings. The Cooperative Research Centre for Freshwater Ecology held taxonomic workshops that targeted many of the aquatic insect groups and other aquatic invertebrate groups to provide reliable keys to 'voucher' taxa based on morphological characteristics of the nymphal and larval stages. This recognised that much of the taxonomy of the aquatic insects was based on the short lived adult stages, but the biological assessment of rivers throughout Australia was dealing with the juvenile stages, which are long-lived, but not associated with adults. These workshops increased the taxonomic work on the aquatic insects' nymphs and larvae, and addressed the coordination issue by providing a voucher name or number based on the best taxonomy available.

Also, since the paper by Butcher and Doeg (1995), there has been a series of national collections (e.g. Monitoring River Health, First National Assessment of River Health) which have provided systematic collections using standard methods. These programmes used rapid biological assessment methods and the collections were identified only to Family level, thus limiting their value in providing distributional data for any particular taxon. However, a project to use these collections and identify some of the aquatic insects to the lowest taxonomic level (morphological voucher species) was undertaken by the Australian Biological Resources Study and the Natural Heritage Trust (Suter *et al.* 2006). This has enabled an assessment of the distribution, ecology and habitat use by some 200 taxa. This work has highlighted some conservation issues with a number of taxa that are only rarely recorded or are restricted in their distribution in Victoria.

Suter *et al.* (2006) recorded at least eight mayfly species (*Edmundsiops* MVsp. 9, *Pseudocloeon hypodelum* Lugo-Ortiz, *Wuudacaenis flabellum* Suter, *Atalophlebia* AV2, *Atalophlebia* AV6, *Ameletoides* sp., *Tasmanophlebia* AV2 and *Coloburiscoides* sp.) and five caddisfly species (*Daternomina* AV11, *Ecnomina* AV3, *Ecnomina* AV22, *Ecnomus nibbor* Cartwright and *Hydrobiosella* AV4) that were restricted to less than five locations in Victoria. Only three of these species have been formally described and named, with all the others known only by their Australian Voucher Number. This highlights the taxonomic impediment that exists with the freshwater insects. Even though the taxonomic workshops enabled the identification of nymphs and larvae of the major insect Orders with illustrated keys, complete descriptions and formal naming has been limited, due to inadequate funding for taxonomic research. Consequently, there may be a number of extinctions that have already occurred but the species have never been recognised (Strayer 2006).

***Coloburiscoides* – perception may not be reality**

The Family Coloburiscidae includes a single genus *Coloburiscoides* that currently consists of three described species and appears widespread throughout the Australian Alps in New South Wales, the Australian Capital Territory and Victoria (Campbell 1981; Marchant and Ryan 2006; Suter *et al.* 2006). Records also exist from streams in the Otway Ranges in Victoria (Suter *et al.* 2006) (Fig. 1). Nymphs of this genus occur in high altitude streams and in the foothill streams draining the Alps. Nymphs have been recorded at a wide range of altitudes from 10 m to 1860 m. They occur in fast flowing water in streams with a substrate dominated by pebbles, cobbles and boulders (Suter *et al.* 2006). They use their elaborate ornamentation of spines on their body and gills (Fig. 2a) to maintain their position between rocks, and the fine hairs that line the femora and tibiae of the forelegs and femora of the mid legs to filter fine particulate organic material from the flowing water. The nymphs live for at least a

Fig. 1. Distribution of all species of *Coloburiscoides* in Australia based on collections made during the Monitoring River Health and First National Assessment of River Health.

year (maybe two years) (Campbell 1986) before they emerge as subimagoes (the Kosciuszko dun) but the imagoes or adults are rarely seen even though they are large (Fig. 2b).

Although evidence of this widespread distribution would suggest these animals are common and abundant there is a major concern in that the species can only be identified from the adults, and not from the more commonly collected nymphs. No reliable characteristics have been found to distinguish the different species in the nymphal form. Consequently, in ecological and biogeographical studies (Campbell 1981) all species are combined at the generic level, which provides the perception that this genus is widespread and common and that each species is also common. However, as with all combined data, there is a loss of information, and individual species may not be common or widespread but, in fact, be potentially endangered.

A recent study (McGuffie 2005) used mitochondrial DNA (cytochrome *c* Oxidase Subunit I gene; COI) to distinguish species of *Coloburiscoides* nymphs from numerous locations within the Australian Alps. These analyses indicated four distinct species based on the COI gene. Of these, at least two species had a very restricted distribution, limited to two or three locations. In addition these locations were at altitudes above 1000 m ASL with most in mountain top streams above the tree line.

The two species which are of major conservation concern are both endemic species; *Coloburiscoides giganteus* (Tillyard) from the Mt Kosciuszko area in New South Wales and an undescribed species currently known only from the Bogong High Plains. Both of these species are large (body size in adults and mature nymphs >20 mm) and occur in association with larger substrate particle sizes (cobbles and boulders). The smaller species (body size in adults and nymphs <18 mm) were associated with pebbles, sand and logs (McGuffie 2005).

These two species have the potential of being listed as Vulnerable, Rare or Threatened. *Coloburiscoides giganteus* has been recorded from only three locations in New South Wales: Diggers Creek (Kosciuszko National Park, KNP) Thredbo River at Dead Horse Gap (KNP) and Leather Barrel Creek (confirmed by adult and DNA analysis). There are unconfirmed records (adults only) from the Upper Macalister River and upper Western Tyers River in Victoria (Campbell 1983). The second species recorded from the Bogong High Plains is common in streams within the National Park and Falls Creek resort, but it appears restricted to this area above 1200 m ASL.

Threatening Processes

Butcher and Doeg (1995) gave a preliminary list of threatening processes for aquatic invertebrates (i.e. flow alteration, temperature changes, sediment input, removal of wood debris, inputs of toxic substances). In recent years, two major threatening processes have become apparent particularly in the Australian Alps: fire caused by lightning strikes, and climate change. Clunie and Reed (1995) noted that the *Flora and Fauna Guarantee Act 1988* gave the ability to list communities as threatened and thereby protect numerous species rather than individual species. The alpine habitats are so listed, but the threats of fire and climate change are still relevant.

Following the 2003 fires in the Australian Alps, the abundance of filter feeding aquatic invertebrates declined dramatically and *Coloburiscoides* nymphs in the foothills streams became rare to absent following runoff from burnt catchments. In the Tallangatta Valley where *Coloburiscoides* nymphs were abundant in the late 1990s only a solitary animal at one site was found following ash laden runoff in 2003 (Suter, pers. obs.). Similar reductions were recorded downstream of the Buckland River in the Ovens River catchment following a flash flood in 2003 (Anon 2003) with reductions in the macroinvertebrates and *Coloburiscoides* (raw data provided by the Victorian EPA). Other studies by the EPA (Anon 2004, 2006) also compared the river health changes post fire and noted that the impact of fire was related to the subsequent rainfall and runoff, patchiness of the fires and the sources of recolonisation (Anon 2006). The raw data from the EPA monitoring of the fire impacts indicated that *Coloburis-*

Fig. 2. Nymph of *Coloburiscoides giganteus* from Kosciuszko National Park (above), and female imago of *Coloburiscoides* sp (below) from the Bogong High Plains.

coides numbers did recover over an 18 month period after the fires. Crowther and Papas (2005) compared the macroinvertebrate communities of burnt and unburnt streams on the Bogong High Plains but *Coloburiscoides* was not mentioned as an indicator of river health change. Intense fire and runoff into streams of the alpine zone has the potential of eliminating some populations of *Coloburiscoides* from the limited locations where they occur. The threat of fires in the Australian Alps is likely to be increased with the second major threatening process, climate change. With predictions of between 2° C and 6° C increase in global temperature this century, the possible impacts on the alpine environment include a decrease in snow cover during winter, an increase in extreme frost events, altitude rise in the subalpine zone and a decline in the area of the alpine zone (Good 1998). Snow cover insulates the ground (Green 1998) and allows streams to flow beneath. Estimates of between 18% and 66% reduction in the area covered by snow by 2030 have been made by the Australian Greenhouse Office (Commonwealth of Australia 2002). Under reduced snow cover, the streams and peatlands may be exposed to freezing and thawing (periglacial activity) and a greater intensity of frost crystal formation and frost-heaving (Good 1998) leading to increased sedimentation (Ritter 2006) and reduction of available habitat for the long-lived aquatic fauna. A reduced runoff from snow melt

would also reduce the fast flowing conditions required by many of the aquatic invertebrates (Green and Osborne 1998). Animals that have long life cycles and are filter feeders, such as *Coloburiscoides giganteus* and *Coloburiscoides* sp., would be unlikely to survive such extreme conditions. In addition, another undescribed endemic mayfly *Ameletoides* sp. is also found in some streams on the Bogong High Plains and is subject to the same threats as *Coloburiscoides* sp.

Strayer (2006) considered that conservation of freshwater invertebrates, including insects, face five challenges:

1. thousands of species may already be extinct or imperilled
2. human pressures on water resources are intense and increasing
3. scientific knowledge of invertebrates is significantly poorer than for vertebrates
4. freshwater systems are part of a larger catchment and conservation should focus on all the catchment upstream and not on an individual site
5. society spends little on invertebrate conservation.

The habitat occupied by *Coloburiscoides giganteus* and *Coloburiscoides* sp. are at the top of catchments that are protected in national parks and are therefore not exposed to major human pressures, toxins or land clearance and subsequent erosion. However, despite having some protection these two species of *Coloburiscoides* are still under threat from lack of scientific knowledge, inadequacies of funding for invertebrate conservation and fire caused by lightning strikes and climate change, all of which increase their chances of becoming extinct or critically endangered.

Acknowledgements

The authors wish to thank John Dean and the Victorian EPA for providing the raw data for *Coloburiscoides* numbers at locations affected by the 2003 bushfires.

References

Anon (2003) The impacts of bushfires following a flash flood event in the catchment of the Ovens River: Ovens Catchment Report. Ovens Catchment Report. EPA Victoria, Melbourne.

Anon (2004) River health: A snapshot of the effects of the 2003 bushfires. EPA Victoria, Melbourne.

Anon (2006) The health of streams in north-eastern Victoria in the three years following the 2003 bushfires. Information Bulletin. EPA Victoria, Melbourne.

Butcher R and Doeg TJ (1995) Conservation of freshwater invertebrates. *The Victorian Naturalist* **112**, 15-19.

Campbell IC (1981) Biogeography of some rheophilous aquatic insects in the Australian region. *Aquatic Insects* **3**, 33-43.

Campbell IC (1983) Studies on the taxonomy and ecology of the Australian Siphlonuridae and Oligoneuriidae (Insecta: Ephemeroptera). (Unpublished PhD thesis, Monash University).

Campbell IC (1986) Life histories of some Australian Siphlonurid and Oligoneuriid mayflies (Insecta: Ephemeroptera). *Australian Journal of Marine and Freshwater Research* **37**, 261-288.

Clunie P and Reed J (1995) Protection of invertebrates in Victoria: the *Flora and Fauna Guarantee Act 1988*. *The Victorian Naturalist* **112**, 32-35.

Commonwealth of Australia (2002) Australia's third national communication on climate change. A report under the United Nations framework convention on climate change. Australian Greenhouse Office, Canberra.

Crowther D and Papas P (2005) Determining the impact of fire on invertebrate communities in alpine streams in north-east Victoria. Department of Sustainability and Environment, Technical Report Series No. 156. Arthur Rylah Institute for Environmental Research, Heidelberg.

Good R (1998) Changing snow regimes and the distribution of alpine vegetation. In *Snow; a natural history, an uncertain future*, pp 98-112. Ed K Green. (Australian Alps Liaison Committee, Surrey Beatty & Sons: Canberra)

Green K (1998) A winter niche: the subnivean space. In *Snow; a natural history, an uncertain future*, pp 125-140. Ed K Green. (Australian Alps Liaison Committee, Surrey Beatty & Sons: Canberra)

Green K and Osborne WS (1998) Snow as a defining character of the alpine/subalpine fauna. In *Snow; a natural history, an uncertain future*, pp 141-164. Ed K Green. (Australian Alps Liaison Committee, Surrey Beatty & Sons: Canberra)

Marchant R and Ryan D (2006) Distribution maps for aquatic insects from Victorian rivers and streams: Ephemeropteran and Plecopteran nymphs and Trichopteran larvae. *Museum of Victoria Science Reports* **8**, 1-171.

McGuffie PJ (2005) The systematics of the Australian mayfly genus *Coloburiscoides* (Ephemeroptera: Coloburiscidae). (Unpubished Honours thesis, La Trobe University).

Ritter ME (2006) The Physical Environment: An introduction to physical geography. Accessed 21 May 2007. http://www.uwsp.edu/geo/faculty/ritter/geog101/textbook/title_page.html.

Strayer DL (2006) Challenges for freshwater invertebrate conservation. *Journal of the North American Benthological Society* **25**, 271-287.

Suter PJ, Cartwright D, Dean J, Sutcliffe K, Bryce C, Davies P and Pinder A (2006) Habitat profiles of selected Australian aquatic insects. Department of the Environment and Heritage, Canberra. http://www.deh.gov.au/biodiversity/abrs/publications/electronic-books/aquatic-insects.html.

Received 19 April 2007; accepted 31 May 2007

Dragonfly *Aeshna* sp. (Photograph from FNCV files).

Dainty Swallowtail *Papilio anactus* (Photograph from FNCV files).